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# ANIMAL LIFE AND SEWAGE IN THE GENESEE RIVER, NEW YORK\*

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It is a hopeful sign of permanent improvement in our rivers and streams when commonwealths and municipalities turn their attention to the condition of these waters and provide means for their purification where they have previously been contaminated by sewage, refuse, or chemicals.

It has been known to biologists for many years that sewage and chemicals were inimical to the life inhabiting these waters, but political bodies have been slow to realize or to admit that the pouring of millions of gallons of crude sewage had any effect on the animal life living in such waters. It is even probable in some cases that those in authority cared little about the effect of such contamination, if it provided an easy and economical method of disposing of the sewage. The damage to fish and other aquatic life has not been realized by the engineers in charge of such work and hence this class of scientific men has not protested or sought a better method, at least not until recent years. The work of the various conservation commissions of the several states, as well as the efforts of natural history societies, universities, and private individuals, have brought into prominence the danger from stream pollution and have awakened widespread interest in this important subject.<sup>1</sup>

In Illinois, careful studies are in progress by the Nat-

\* Contribution from the Museum of Natural History, University of Illinois.

<sup>1</sup>See in this connection, Henry B. Ward, "The Elimination of Stream Pollution in New York State," *Trans. Amer. Fisheries Soc.*, XLVIII, pp. 1-25, 1918.

ural History Survey under the direction of Dr. S. A. Forbes, for the purpose of ascertaining the effect in the Illinois River of the large volume of polluted water from the Chicago Drainage Canal, into which all of the sewage of the city of Chicago is discharged.<sup>2</sup> In other places, studies of a similar character are being carried on.

In New York State, the Genesee River, at Rochester, has afforded a striking example of stream pollution, of the effect of this pollution on the animal life in the river, and of the final return of this life after the amount of pollution was notably reduced. It has been the writer's good fortune to visit Rochester every two or three years (sometimes oftener) and to be able to study the condition of the Genesee River during a period of nearly thirty years. Collections were made before, during, and after pollution, permitting comparisons to be made of the life in the river during these several periods of varying conditions.

The animal life in a body of water has been little used as an indicator of the degree of pollution. Fish, especially young fish, have been used and are good indicators because they cannot live in water polluted to any large degree. The relative resistance of different species of fish has been well shown by Shelford in a recent paper.<sup>3</sup> The writer is convinced that mollusks are also good indicators of degrees of pollution. The intimate relation of fish to the propagation of river mussels (*Unionidæ*), so largely used in the manufacture of pearl buttons, is also seriously affected by stream pollution.

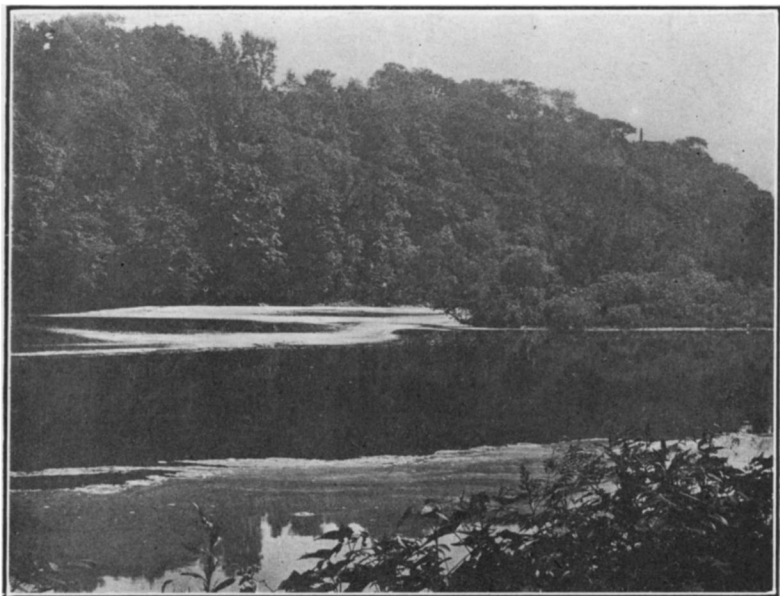
The polluted portion of the Genesee River studied (which was also the place of maximum pollution) lies below the lower falls (Driving Park Avenue bridge), a large sewer discharging some distance below these falls just above the spot known locally as Brewer's landing, near Norton Street, on the east side of the river. Several

<sup>2</sup> See Forbes and Richardson, "Some Recent Changes in Illinois Biology," Illinois Natural History Survey, *Bulletin*, XIII, pp. 139-156, 1919.

<sup>3</sup> *Bull.* XIII, Ill. Nat. Hist. Surv., pp. 25-42, 1918.

other sewers emptied into the river at the north end of Maplewood Park on the west side of the river. The stream for several miles below these points resembled thick, dirty, greasy dish water, a heavy scum covering the surface of the water as well as the shore and any objects in the water.

At the time of maximum discharge, sewer outlets also entered the river both above and below the falls and



The photograph was taken in the summer of 1907. The white streaks in the background are from the trunk line sewer on the east side of the river near Norton Street. The light streak in the foreground is the sewage from the outlet on the west side of the river near the lower falls. A small island on the right side of the picture hides a part of the sewage in the water on the east side of the river. This place is six miles up the river from the mouth.

many manufactories also contaminated the water by discharging chemicals and refuse into the river. At the present time there are no sewers entering the river above the falls. There are two sewer outlets at the northern end of Maplewood Park, one from the residence section west of the river (Dewey Avenue section) and one from the Eastman plant. Sewage is also discharged into the

river at Charlotte near the mouth of the river. This, however, does not enter into the present discussion. It has not been possible to ascertain the amount of sewage entering the river during the period of maximum discharge, but at the present time the approximate quantity of sewage discharged is one-eighth cubic foot per second (data from Rochester engineering department). This is a comparatively small amount which apparently has little or no effect on the animal life in the river. On the contrary, it may provide food for some organisms.

Sewage was turned into the Genesee River about the year 1820. Collections of molluscan life were made in July, 1897, and nine species were obtained, as noted below:

|                              |                              |
|------------------------------|------------------------------|
| <i>Musculium transversum</i> | <i>Physa gyrina</i>          |
| <i>Musculium partumeium</i>  | <i>Physa sayii</i>           |
| <i>Bythinia tentaculata</i>  | <i>Physa heterostrophia</i>  |
| <i>Galba catascopium</i>     | <i>Galba caperata</i> (rare) |
| <i>Planorbis trivolvis</i>   |                              |

Previously, in 1892-1895, collections had been made which included about the same species as noted above. Individuals were notably abundant, thickly covering the rocks and the shore. At the time the above mollusks were collected it was noted that the sewage was increasing in volume and pollution was becoming more noticeable. It was predicted at this time that in a few years the fauna would be exterminated by the foulness of the water.

The river was visited and examined in 1898, 1900, 1901, 1904-1907, 1908, 1910, 1913, 1915-1917, and 1919.<sup>4</sup> Each year it was noted that the pollution of the water was rapidly increasing. In 1907, the water-breathing mollusks, *Musculium* and *Bythinia*, had succumbed and none could be found. The air-breathers, *Galba*, *Planorbis*, *Physa*, still held out, though reduced in number of indi-

<sup>4</sup>See the following papers by the writer: "The Molluscan Fauna of Western New York," *Trans. Acad. Sci. St. Louis*, VIII, pp. 71-94, 1898. "The Molluscan Fauna of the Genesee River," *AMER. NAT.*, XXXV, pp. 659-664, 1901.

viduals. An examination made in 1910 failed to discover a single living mollusk of any species. Apparently, the water had reached such a state of concentrated pollution that even the air-breathing mollusks, which normally come to the surface to take in free air, could not adapt themselves to this unfavorable environment and were either killed or compelled to migrate down the river to a point where the pollution was not so great, a distance of several miles. During the following two or three years the river was visited but no mollusks could be found.

On March 17, 1917, a large part of the city's sewage was diverted to the Irondequoit sewage disposal plant located on the shore of Lake Ontario near the Durand-Eastman Park. Here an average of 32 million gallons of sewage are treated daily, and the treated sewage discharged into Lake Ontario at a distance of 7,000 feet from shore in water 50 deep (vide city engineer's statement). It may easily be seen that when this large amount of sewage, untreated, was discharged into the Genesee River, it could not but render the water totally unfit for animal life and a menace even to the inhabitants who visited the beautiful parks bordering both sides of the river.

The result of the diminution of the amount of sewage discharged into the river has been that the fauna has returned and has rapidly taken possession of the favorable environments which were in use previous to the maximum period of pollution. Collections made in September, 1919, contained the six species noted below:

|                              |                             |
|------------------------------|-----------------------------|
| <i>Musculium transversum</i> | <i>Bythinia tentaculata</i> |
| <i>Planorbis trivolvis</i>   | <i>Galba catascopium</i>    |
| <i>Physa integra</i>         |                             |

*Physa oneida* (previously reported as *heterostrophia*)

It will be noted that practically the same species returned to the Maplewood Park section of the river that lived here before the polluted water exterminated the fauna, indicating, probably, that they migrated up the river from the less affected water below.

Few data are at hand indicating how far the polluted water must flow before it can purify itself enough to become favorable for animal life. In the Illinois River, life is being affected by the Chicago sewage at Peoria, a distance of 110 miles from the source of infection. A recent study of the Salt Fork of the Vermilion River, into which the sewage of Champaign and Urbana is discharged, indicated that the polluted water was inimical to molluscan life for a distance of 14 miles in which no living mollusks were found, and one must pass down the stream for a distance of nearly twenty miles before a normal mussel fauna can be found.

In the Allegheny River, Ortmann found that whole stretches of the stream and some of its tributaries had been made into a desert by pollution, principally in the form of chemicals from the numerous mines situated in this part of the State. Ortmann remarks that "with regard to the animal life in our rivers, sewage does not seem to be harmful; on the contrary, certain forms (fishes, crawfishes, mussels) seem to thrive on it" (p. 97). This is probably true in a case where water is but slightly contaminated; but in streams where pollution by sewage is greatly concentrated (a condition reached sooner or later in all streams used for sewage disposal) it is certainly inimical to the forms of life mentioned. It is very true that a stream polluted by chemicals soon becomes destitute of the larger forms of animal life (if, indeed, not all life) and in such waters the return of life will be very slow and in many cases it may be impossible for life to return on account of the chemicals which cover the bottom and shores.

In the case of the Genesee River, we have a striking example of the history of a polluted stream and its effect on the animal life. Previous to the discharge of sewage into the stream there was a varied molluscan fauna very numerous in individuals. In the course of eleven years the gill-bearing mollusks were forced out and after a lapse of fourteen years all molluscan life ceased to live

in this portion of the river. Seven years later, the greater amount of sewage was diverted to another outlet. Two years after this diminution of pollution we find that the molluscan fauna has returned in as great number of individuals as were found there before pollution began. In other words, it required but two years (possibly less, as the river was not examined in 1918, one year after the conditions changed) for the river to become pure enough to provide a favorable environment for molluscan life. It has been reported that the sturgeon is again resorting to the lower portion of the river for spawning purposes, after an absence of several years, due to the heavy pollution of the water. The rapid return to a favorable condition is partly due to the lower falls in the river which abundantly aerates the water before it is mixed with the small amount of sewage now flowing into the stream.

It may be affirmed without successful contradiction that wherever sewage pollution occurs, sooner or later the animal life will be affected, and finally driven out. As this condition seriously concerns our food and game fishes, which form so large a part of the meat food of our population, it is a situation that demands immediate attention and early remedy. That the fauna recovers so quickly after pollution ceases is a matter of great interest and satisfaction, showing what favorable returns may be expected when these matters are taken up in all earnestness by municipalities and commonwealths.

#### POLLUTION IN THE GENESEE RIVER

Since writing the above account of the effect of sewage pollution on the molluscan life of the river, Mr. John F. Skinner, principal assistant engineer of the Rochester Department of Engineering, who has been connected with this department for upwards of twenty-eight years, has kindly read the paper and has indicated several inaccuracies in the historical matter, besides adding much information of value concerning the sewage disposal of the city. The following data are all supplied by Mr. Skinner:

Rochester was settled in 1812, incorporated as a village in 1817, and as a city in 1834. The first sewers were built about 1820. All of the city west of the river and roughly everything within a mile east drained into the river. A sewer 4 by 6 feet in diameter was in operation in 1863. In 1896 nine main outfalls were in operation, five on the west side and four on the east side. In 1897 the west side trunk sewer nine feet in diameter was put in operation. Four of these sewer outfalls are below the lower falls, two being above the point at which the molluscan studies were made.

Fourteen stormwater sewers overflow into the river above the lower falls. Refuse and waste matter, both liquid and solid, enter the stream from a tannery, gas works, breweries, garbage disposal plants and some other manufacturing plants. The breweries do not now contaminate the water as formerly. This additional pollution is sometimes more harmful to animal life than the sewage itself. In March, 1917, the main (Irondequoit) sewage disposal plant was put in operation on the shore of Lake Ontario. The outfall to this plant intercepts the dry weather flow of all of the sewer outlets mentioned above, except the Lake Avenue or Dewey Avenue outlet on the west side about 6,000 feet below the lower falls. There is also a large outlet further north, down the river, from the Eastman Kodak plant and adjacent territory. The overflows from the east and west side trunk sewers enter below the lower falls, as will also that from the Lake Avenue sewer after the Maplewood plant is completed. The clarified effluent of the last mentioned plant will also enter the river, but the major portion of the solids (contained in the sludge) will be pumped across the river to the east side interceptor.

In a report issued in 1913,<sup>5</sup> Mr. George C. Whipple, consulting engineer, has published much valuable information relating to the effect of the sewage pollution on

<sup>5</sup> "Report on the Sewage Disposal System of Rochester, N. Y.," by Edwin A. Fisher, city engineer. See pages 179-200.

the river and on some of the animal and vegetal life. This study was made in 1912 when the pollution was at its maximum and during the period when molluscan life had disappeared from the upper part of the river below the lower falls. The dissolved oxygen in the lower river, below the trunk line sewer, in July and August when the temperature was high and the water low, varied from 5 to 41 per cent. of saturation. The water at the bottom of the river almost always contained less oxygen than that at the surface. This condition prevailed to within a short distance of the mouth of the river when the reverse was true, this change being due to the backflow of the well-oxygenated water from Lake Ontario. Near the east side trunk sewer, which is about half a mile below the lower falls, the percentage of saturation varied from 5 to 60 between July 1 and August 13. On August 13, the percentage of saturation between the east side trunk sewer and a point two and a half miles from the lake (a distance of about three miles) did not exceed five per cent. This area includes the shores examined for the Mollusca. The percentage of dissolved oxygen saturation was usually higher at the surface than at the bottom of the river, the heavier parts of the sewage falling to the bottom and forming sludge banks. The percentage of dissolved oxygen also did not vary directly with the amount of evident pollution, for on a day in July when the most disagreeable conditions existed for a mile and a half below the east side outlet the dissolved oxygen at the surface varied from 40 to 70 per cent.

A study of the plankton of the river indicated that near the source of pollution,  $5\frac{1}{2}$  miles above the mouth of the river, there were on the average in July and August, 1,650,000 bacteria, 156 algæ, 209 Protozoa, and 57 Crustacea and Rotifers per cubic centimeter. At the mouth of the river the figures for these organisms per c.c. stood as follows: 67,000; 363; 77; 233. It is unfortunate that no discrimination was made between the foul water algæ and protozoa and those normally inhabiting pure water,

which would have made a difference in the number from the standpoint of pollution. This has been done by Forbes and Richardson in their studies of the Illinois River pollution.<sup>6</sup>

A comparison of the report made by Engineer E. Kuichling, Feb. 1, 1907 (1913 report, pp. 5-42) with that of Mr. Whipple made in 1912 shows in a striking manner the rapid increase of polluted conditions, the former author describing conditions as not very bad (pp. 10-11) while the latter author, five years later, describes the conditions as very bad (p. 182). It was between these dates, 1907 and 1912, that the molluscan fauna disappeared and it is apparent that the distinct increase in toxicity is indicated from these several angles of vision.

It should be stated in connection with the ill effects of sewage pollution that it affects the population in an indirect manner not usually recognized by sanitary engineers who have not interested themselves in the problem of fish culture. Such places as the six miles of shallow shore bordering the Genesee River are the breeding and feeding ground of such valuable food and game fish as the sturgeon, black bass, sunfish, suckers, bullheads, pickerel, pike, etc., and the young of these and other fish spend a large part of their life in this kind of a habitat, to later migrate into the open lake.

<sup>6</sup> "Studies on the Biology of the Upper Illinois River," *Bull. Illinois State Laboratory of Natural History*, IX, pp. 481-574, 1913.